

## CLAIMS

### WHAT IS CLAIMED IS:

1. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals  
5 to/from a wavelength-multiplex signal transferred through an optical multiplex transmission  
line, the optical signals having different wavelengths from each other and being individually  
transmitted or received by a plurality of signal conversion apparatuses;

a reference signal receiving section for receiving a reference optical signal modulated  
according to a reference signal which is outputted from a specific one of said plurality of  
10 signal conversion apparatuses, and is a reference to synchronization in all or a part of said  
plurality of signal conversion apparatuses; and

a reference signal distributing section for distributing the received reference optical  
signal to all or a part of said plurality of signal conversion apparatus.

2. The wavelength multiplexing apparatus according to claim 1, wherein:

15 said specific signal conversion apparatus wavelength-multiplexes said reference  
optical signal to an optical signal to be transmitted from the specific signal conversion  
apparatus; and

said reference signal receiving section receives said reference optical signal by  
demultiplexing or extracting said reference optical signal from said optical signal in  
20 wavelength region.

3. The wavelength multiplexing apparatus according to claim 1, wherein:

said reference signal receiving section receives reference optical signals individually  
supplied from a plurality of specific signal conversion apparatuses among said plurality of  
signal conversion apparatuses; and

25 said reference signal distributing section distributes one of the reference optical

signals received by said reference signal receiving section.

4. The wavelength multiplexing apparatus according to claim 1, wherein;

said reference signal receiving section receives reference optical signals which are individually supplied from said plurality of specific signal conversion apparatuses and have a correspondence in advance with all or a part of said specific signal conversion apparatuses and said optical multiplex transmission line; and

said reference signal distributing section distributes the individually received reference optical signals to said signal conversion apparatuses corresponding to the reference optical signals or said optical multiplex transmission line.

5. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses;

a reference signal generating section for generating a reference optical signal modulated according to a reference signal which is a reference to synchronization in said plurality of signal conversion apparatuses; and

a reference signal distributing section for distributing the generated reference optical signal to all or a part of said plurality of signal conversion apparatuses.

6. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses;

a reference signal receiving section for receiving a reference optical signal modulated

according to a reference signal which is outputted from a specific one of said plurality of signal conversion apparatuses, and is a reference to synchronization in all or a part of said plurality of signal conversion apparatuses; and

a reference signal distributing section for distributing the received reference optical signal to all or a part of said plurality of signal conversion apparatuses, and wherein:

said multiplexing section includes an optical amplifier for optically amplifying a wavelength-multiplex signal transferred through said optical multiplex transmission line and all or a part of optical signals demultiplexed from the wavelength-multiplex signal; and

said reference signal distributing section distributes said received reference optical signal by modulating pumping light to be used for said optical amplification, by the reference optical signal.

7. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses;

a reference signal generating section for generating a reference optical signal modulated according to a reference signal which is a reference to synchronization in said plurality of signal conversion apparatuses; and

a reference signal distributing section for distributing the generated reference optical signal to all or a part of said plurality of signal conversion apparatuses, and wherein:

said multiplexing section includes an optical amplifier for optically amplifying a wavelength-multiplex signal transferred through said optical multiplex transmission line and all or a part of optical signals demultiplexed from the wavelength-multiplex signal; and

said reference signal distributing section distributing said generated reference

optical signal by modulating pumping light to be used for said optical amplification, by the generated reference optical signal.

8. A signal conversion apparatus comprising:

a converting section for performing bidirectional or unidirectional conversion  
5 between a signal transferred through a transmission line, and an optical signal multiplexed to a wavelength-multiplex signal transferred through an optical multiplex transmission line or an optical signal to be multiplexed thereto; and

a reference signal receiving section for receiving a reference optical signal modulated  
10 according to a reference signal which is supplied from a wavelength multiplexing apparatus and is a reference to synchronization with said transmission line, the wavelength multiplexing apparatus being for multiplexing and/or demultiplexing said optical signal to/from said wavelength-multiplex signal, and wherein

said converting section synchronizes with the said transmission line based on the received reference optical signal.

15 9. The signal conversion apparatus according to claim 8, wherein:

said reference optical signal is wavelength-multiplexed to a specific optical signal by said wavelength multiplexing apparatus, the specific optical signal being demultiplexed from said wavelength-multiplex signal by the wavelength multiplexing apparatus; and

said reference signal receiving section receives said reference optical signal by  
20 demultiplexing or extracting in wavelength region.

10. The signal conversion apparatus according to claim 8, wherein

said reference optical signal is supplied via a specific channel used for transferring information about maintenance or operation of an optical transmission system including said optical multiplex transmission line.

25 11. A signal conversion apparatus comprising:

a converting section for performing bidirectional or unidirectional conversion between a signal transferred through a transmission line, and an optical signal multiplexed to a wavelength-multiplex signal transferred through an optical multiplex transmission line or an optical signal to be multiplexed thereto; and

5 a reference signal transmitting section for transmitting a reference optical signal modulated according to a reference signal being a reference for synchronization with said transmission line, to a wavelength multiplexing apparatus for multiplexing and/or demultiplexing said optical signal to/from said wavelength-multiplex signal.

12. The signal conversion apparatus according to claim 11, wherein:

10 a wavelength of said reference optical signal is different from a wavelength of said optical signal; and

said reference signal transmitting section transmits said reference optical signal to said wavelength multiplexing apparatus as a specific optical signal which is wavelength-multiplexed to said optical signal.

15 13. The signal conversion apparatus according to claim 11, wherein:

said converting section includes an optical amplifier for optically amplifying an optical signal to be transmitted to said wavelength multiplexing apparatus; and

said reference signal transmitting section transmits said reference optical signal by modulating pumping light to be used for said optical amplification, according to said reference optical signal.

20 14. The signal conversion apparatus according to claim 11, wherein

said reference optical signal is supplied via a specific channel used for transferring information about maintenance or operation of an optical transmission system including said optical multiplex transmission line.

25 15. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses; and

5 an ancillary modulating section for modulating a wavelength-multiplex signal to be demultiplexed by said multiplexing section, according to information about one or both of maintenance and operation of said signal conversion apparatuses.

16. The wavelength multiplexing apparatus according to claim 15, wherein

10 said ancillary modulating section modulates said wavelength-multiplex signal according to said information about one or both of maintenance and operation, by modulating an intensity of pumping light used for amplification of the wavelength-multiplex signal.

17. A wavelength multiplexing apparatus comprising:

15 a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses; and

20 an ancillary modulating section for modulating a specific optical signal having a wavelength different from wavelengths of optical signals multiplexed to said wavelength-multiplex signal, according to said information about one or both of maintenance and operation of said plurality of signal conversion apparatuses, and wherein

said multiplexing section distributes the modulated specific optical signal to said signal conversion apparatuses.

18. A wavelength multiplexing apparatus comprising:

25 a multiplexing section for multiplexing and/or demultiplexing optical signals

to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses; and

an ancillary modulating section for modulating a specific optical signal whose wavelength is different from wavelengths of optical signals multiplexed to said wavelength-multiplex signal, according to individual information about one or both of maintenance and operation of a part of said signal conversion apparatuses, and wherein

said multiplexing section distributes the modulated specific optical signal to said part of said signal conversion apparatuses.

19. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses; and

an ancillary modulating section for individually modulating a plurality N of specific optical signals having wavelengths different from wavelengths of optical signals multiplexed to said wavelength-multiplex signal, according to individual information about one or both of maintenance and operation of said plurality of signal conversion apparatuses, and wherein

said multiplexing section individually distributes said plurality N of optical signals modulated by said ancillary modulating section to said plurality of signal conversion apparatuses.

20. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually

transmitted or received by a plurality of signal conversion apparatuses; and

an amplifying section for amplifying a wavelength-multiplex signal to be demultiplexed by said multiplexing section, according to pumping light modulated based on information about one or both of maintenance and operation of said signal conversion apparatuses.

21. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses; and

an optical interface section for supplying, to said multiplexing section, a specific optical signal modulated according to information about one or both of maintenance and operation of said plurality of signal conversion apparatuses, the specific optical signal having a wavelength different from wavelengths of optical signals multiplexed to said wavelength-multiplex signal, and wherein

said multiplexing section distributes the supplied specific optical signal to one of said plurality of signal conversion apparatuses based on wavelength division multiplexing.

22. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses and modulated based on information about one or both of maintenance and operation of the plurality of signal conversion apparatuses; and

a maintenance operation assisting section for reconstructing said information about



one or both of maintenance and operation and delivering the information to a terminal used for the maintenance or the operation, by demodulating a wavelength-multiplex signal generated during the process of multiplexing by said multiplexing section.

23. A wavelength multiplexing apparatus comprising:

a multiplexing section for multiplexing and/or demultiplexing both optical signals and specific optical signals to/from a wavelength-multiplex signal transferred through an optical multiplex transmission line, the optical signals having different wavelengths from each other and being individually transmitted or received by a plurality of signal conversion apparatuses, the specific optical signals being individually transmitted by all or a part of said plurality of signal conversion apparatuses and being modulated according to information about one or both of maintenance and operation; and

a maintenance operation assisting section for reconstructing said information about one or both of maintenance and operation and delivering the information to a terminal used for the maintenance or the operation by demodulating a wavelength-multiplex signal generated during the process of multiplexing by said multiplexing section.

24. A signal conversion apparatus comprising:

a converting section for performing bidirectional or unidirectional conversion between a signal transferred through a transmission line, and an optical signal multiplexed to a wavelength-multiplex signal transferred through an optical multiplex transmission line or an optical signal to be multiplexed thereto; and

an ancillary modulating section for modulating an optical signal to be multiplexed to said wavelength-multiplex signal, according to one or both of information about maintenance and operation.

25. The signal conversion apparatus according to claim 24, wherein

said ancillary modulating section modulates an optical signal according to said

information about one or both of maintenance and operation by modulating an intensity of pumping light to be used for amplification of the optical signal to be multiplexed to said wavelength-multiplex signal.

26. A signal conversion apparatus comprising:

5 a converting section for performing bidirectional or unidirectional conversion between a signal transferred through a transmission line, and an optical signal multiplexed to a wavelength-multiplex signal transferred through an optical multiplex transmission line or an optical signal to be multiplexed thereto; and

10 an ancillary modulating section for modulating a specific optical signal having a different wavelength from a wavelength of an optical signal multiplexed to said wavelength-multiplex signal, according to information about one or both of maintenance and operation, and wherein

15 said converting section distributes an optical signal to be multiplexed to said wavelength-multiplex signal and the specific optical signal modulated by said ancillary modulating section to a wavelength multiplexing apparatus, based on wavelength division multiplexing, the wavelength multiplexing apparatus being for multiplexing and/or demultiplexing the wavelength-multiplex signal transferred through said optical multiplex transmission line.

27. A signal conversion apparatus comprising:

20 a converting section for performing bidirectional or unidirectional conversion between a signal transferred through a transmission line, and an optical signal being demultiplexed from a wavelength-multiplex signal transferred through an optical multiplex transmission line, and being modulated according to information about one or both of maintenance and operation, or an optical signal to be multiplexed to the wavelength-multiplex signal; and

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a maintenance operation assisting section for reconstructing said information about one or both of maintenance and operation by modulating an optical signal generated during the process of said conversion and modulated based on the information, and for delivering the information to a terminal used for one of the maintenance and the operation.

5    28.    A signal conversion apparatus comprising:

10           a converting section for performing bidirectional or unidirectional conversion between a signal transferred through a transmission line, and an optical signal demultiplexed from a wavelength-multiplex signal transferred through an optical multiplex transmission line and a specific optical signal modulated according to information about one or both of maintenance and operation, or an optical signal to be multiplexed to the wavelength-multiplex signal; and

15           a maintenance operation assisting section for reconstructing said information about one or both of maintenance and operation by modulating an optical signal generated during the process of said conversion and modulated based on the information, and for delivering the information to a terminal used for one of the maintenance and the operation.